

**CLAIMS**

- 1 1. A method for integrating traffic shaping and link sharing functions to enable scaling of  
2 a plurality of queues multiplexed to media links of an intermediate station in a computer  
3 network, the queues storing data packets that are destined for the media links, the method  
4 comprising the steps of:  
5       assigning committed information bit rate (CIR) and excess information bit rate  
6 (EIR) bandwidth values per queue, along with a shaped maximum bit rate per media link;  
7       uniformly scaling the EIR bandwidths of all queues sharing a media link so that  
8 the sum of all scaled EIR bandwidths equals an available bandwidth of the shaped media  
9 link;  
10       calculating when a queue is next eligible for servicing; and  
11       storing event notifications that are triggered when a queue is eligible for servic-  
12 ing.
- 1 2. The method of Claim 1 wherein the step of storing comprises the step of providing a  
2 timing wheel having a plurality of fields per time slot, wherein the fields represent differ-  
3 ent service priorities of queues.
- 1 3. The method of Claim 2 wherein the step of providing a timing wheel comprises the  
2 step of configuring pointers to the queues to enable early forwarding of the packets to  
3 thereby obviate overhead incurred when searching the timing wheel for other references  
4 to the packets.
- 1 4. The method of Claim 3 wherein the step of providing a timing wheel further com-  
2 prises organizing the timing wheel as a contiguous array of time slots containing pointers  
3 to linked lists.
- 1 5. The method of Claim 4 wherein the contiguous array is a hash array and wherein the  
2 linked lists are hash lists.

1 6. The method of Claim 3 wherein the step of providing a timing wheel further com-  
2 prises organizing the timing wheel as a descriptor ring having a plurality of per-time-slot  
3 queues.

1 7. A system for integrating traffic shaping and link sharing functions to enable scaling of  
2 a plurality of queues multiplexed to media links of an intermediate station in a computer  
3 network, the queues storing data packets that are destined for the media links, the system  
4 comprising:

5 queuing logic configured to organize the queues into class queues of a plurality of  
6 queue sets, each queue set coupled to inputs of a sublink multiplexer having an output  
7 coupled to a media link via a media link queue; and

8 a queue scheduler configured to assign each class queue committed information  
9 bit rate (CIR) and excess information bit rate (EIR) bandwidths, and the media link a  
10 shaped maximum bit rate.

1 8. The system of Claim 7 wherein the queue scheduler comprises a EIR scaler that uni-  
2 formly scales the EIR bandwidths of all queues sharing a media link so that the sum of all  
3 scaled EIR bandwidths equals an available bandwidth of the shaped media link.

1 9. The system of Claim 8 wherein the queue scheduler further comprises a virtual time  
2 policer (VTP) configured to determine whether the media links are compliant and to cal-  
3 culate when a queue is next eligible for servicing.

1 10. The system of Claim 9 wherein the queue scheduler further comprises a timing wheel  
2 for storing event notifications that are triggered when a queue is eligible for servicing.

1 11. The system of Claim 10 wherein the timing wheel is organized as a contiguous array  
2 of time slots containing pointers to linked lists, wherein each list contains a plurality of  
3 entries of queue descriptors.

- 1 12. The system of Claim 11 wherein the queue descriptors include a queue index that  
2 references a class queue of the queuing logic.
- 1 13. The system of Claim 12 wherein the queue descriptors include a media link interface  
2 that references a media link coupled to the intermediate station.
- 1 14. The system of Claim 12 wherein the queue descriptors include a priority value indi-  
2 cating a priority level assigned to a queue.
- 1 15. The system of Claim 10 wherein the timing is organized as a descriptor ring having a  
2 plurality of per-time-slot queues.
- 1 16. The system of Claim 15 wherein the descriptor ring comprises an array of time slots,  
2 wherein each slot contains a queue-depth index that references a tail of a list of descrip-  
3 tors.
- 1 17. A method for integrating traffic shaping and link sharing functions to enable scaling  
2 of a plurality of queues multiplexed to media links of an intermediate station in a com-  
3 puter network, the queues storing data packets that are destined for the media links, the  
4 method comprising the steps of:  
5       notifying a queue scheduler when each packet is forwarded to a queue;  
6       determining if the queue is inactive for a committed information bit rate (CIR)  
7 and for an excess information bit rate (EIR);  
8       if the queue is inactive for the CIR, activating the CIR and incrementing an ag-  
9 gregate CIR bandwidth for a media link;  
10       if the queue is not inactive for the CIR, activating the EIR rate and incrementing  
11 the aggregate EIR bandwidth for the link; and  
12       calculating an EIR scale factor of the link.

1 18. The method of Claim 17 further comprising the steps of:  
2 retrieving a queue descriptor from the timing wheel;  
3 comparing a calculated link VTP timestamp of a media link queue with a current  
4 real time and burst value to ensure that collisions between an eligible queue and other  
5 queues do not cause the media link queue to exceed a configurable limit;  
6 if the media link queue does not exceed the configurable limit, issuing a dequeue  
7 command to the queuing logic for the eligible queue;  
8 in response to the command, dequeuing a packet from the eligible queue;  
9 returning a length of the dequeued packet as dequeue status to the queue sched-  
10 uler; and  
11 if the queue length is non-zero, sending the dequeued packet to a media control-  
12 ler for loading into the media link queue.

1 19. The method of Claim 18 further comprising the steps of:  
2 periodically sending depth threshold status of the media link queue to the queue  
3 scheduler;  
4 if the depth threshold status indicates that there are more bits in the media link  
5 queue than the link VTP timestamp represents, incrementing the link VTP timestamp;  
6 correlating the dequeue status with the issued dequeue command;  
7 if a dequeued byte count is non-zero, marking the queue as eligible for servicing;  
8 if the dequeued byte count is zero, deactivating one of the CIR and EIR of the  
9 queue; and  
10 decrementing one of the CIR and EIR aggregate bandwidths of the link.

1 20. The method of Claim 19 further comprising the steps of:  
2 recalculating the EIR scale factor for the link;  
3 calculating the link VTP timestamp;  
4 calculating a queue VTP timestamp; and

5 inserting the queue descriptor onto the timing wheel in the quantum correspond-  
6 ing to one of the queue VTP timestamp, a next time slot and further in time as determined  
7 by a deferral heuristic.

[illegible]